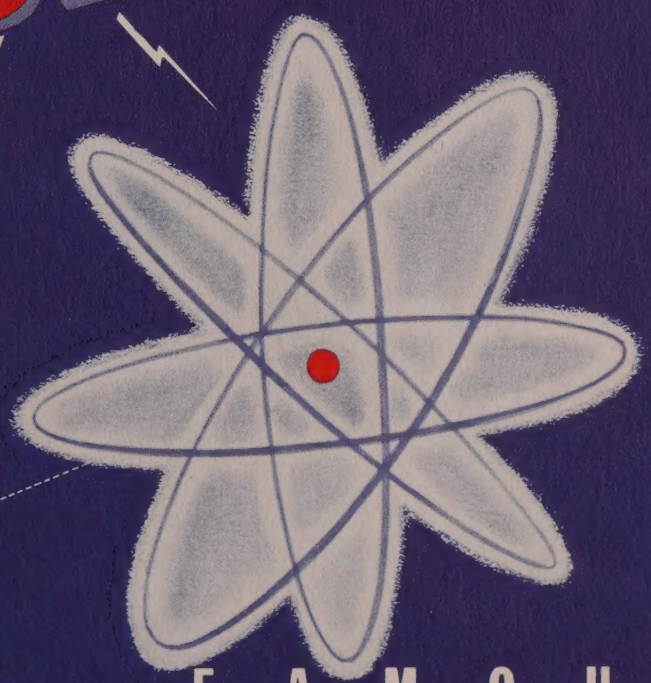
OPERATING INSTRUCTIONS

ELECTRONIC VOLT-OHMMETER

MODEL 215

HICKOK



WORLD FAMOUS

THE HICKOK ELECTRICAL INSTRUMENT COMPANY
10514 DUPONT AVENUE • CLEVELAND 8, OHIO
The Standard of Quality for Over 40 Years

ELECTRONIC VOLT-OHMMETER

MODEL 215

THE HICKOK ELECTRICAL INSTRUMENT COMPANY
10514 DUPONT AVENUE
CLEVELAND 8, OHIO

1B-215-851

FIGURE 1.1 ELECTRONIC VOLT-OHMMETER, MODEL 215

REVISIONS TO THE OPERATING INSTRUCTIONS
FOR THE MODEL 215 VOLT-OHMMETER
(Code Number 2490-163)

The following changes should be made in the Model 215 instruction book to correct errors existing on the original printing:

Title Page - Change revision date in lower left corner to: 1B-215-852

Page ii, Technical Data: Change code number of red test lead to 12450-152
Add Probe Assembly, AC-DC, code number 16970-20

Page 1 - Figure 2.1 - In this drawing, the forward position of the slide switch should be labeled AC and away from the prod tip should be labeled DC.

Page 2 - Paragraph 2.4 - Delete the last sentence and insert the following:
"With the FUNCTION SELECTOR on +DC VOLTS and zero volts applied, advancing the ZERO ADJUST will bring the meter to center scale, providing for a zero center DC voltage measurement."

Page 3 - Paragraph 3.2b -This should read: Operate the slide switch on the probe forward to the AC position.

Page 4 - sub-paragraph e- This should read: Operate the slide switch on the probe away from the prod to the DC position.

Pages 6-7, Parts List - Resistor R31 should be changed from 10% to 5% tolerance.
The code number should be 18413-511
Change Lead Ass'y, Red - to code number 12450-152
Add: Probe Ass'y, AC-DC, Code number 16970-20

Page 8 - Schematic Wiring Diagram - This is Dwg. #765W, Alteration B
This change was made to correct an error existing in the original dwg. No changes were made in the circuits of the instrument.

THE HICKOK ELECTRICAL INSTRUMENT COMPANY
10514 Dupont Avenue
Cleveland 8, Ohio

TECHNICAL DATA SHEET

EQUIPMENT SUPPLIED

(ONE COMPLETE UNIT)

Quan.	Name	Type	Stock No.	Dimensions	Weight
1	Electronic Volt-Ohmmeter	215	902-194	5-3/4 x 8-3/8 x 4-1/2"	4-1/2 lbs.
1	Instruction Book		2490-163	8-1/2 x 11"	
1	AC-DC Cable & Probe Assy.		3025-87	48"	
1	Test Lead, Red - Ohms		12450-98	48"	
1	Test Lead, Black - Gnd.		12450-99	48"	

TECHNICAL CHARACTERISTICS

1. POWER SUPPLY REQUIRED: 105-125 V, 50-1200 cycles, AC.

2. POWER CONSUMPTION: 20 watts at 115 volts

3. SCALES:
   a. Volts DC - RMS: O - 1.5, O - 3, O - 12
      - Zero Center: O - 1.5, O - 6
   b. Volts AC - RMS: O - 3
      - Peak-to-Peak: O - 4, O - 8, O - 32, O - 80
   c. Ohms: O - 1000 - Inf.

4. RANGES:
   a. Volts DC: O - 1.5, 3, 12, 30, 120, 300, 1200
   b. Volts AC - RMS: O - 1.5, 3, 12, 30, 120, 300, 1200
      - Peak-to-Peak: O - 4, 8, 32, 80, 320, 800, 3200
   c. Ohms: 0.2 ohm to 1000 megohms in 7 ranges

5. FREQUENCY: AC RMS or Peak-to-Peak up to approximately 3 mc.

6. INPUT IMPEDANCE:
   a. Volts DC: 10.5 megohms
   b. Volts AC: Inf. ohms shunted by 150 mmf.

7. METER: Model S66, Style 660-004
   Sensitivity: 200 microamperes

8. TUBE COMPLEMENT:

Quan.	Tube	Stock No.	Function
1	12AU7	20875-69	Vacuum tube voltmeter
1	6AL5	20875-51	AC Input Rectifier

STANDARD RTMA GUARANTEE

The Hickok Electrical Instrument Company warrants instruments manufactured by it to be free from defective material or factory workmanship and agrees to repair such instruments which, under normal use and service, discloses the defect to be the fault of our manufacturing. Our obligation under this warranty is limited to repairing any instrument or test equipment which proves to be defective, when returned to us, transportation prepaid, within ninety (90) days from the date of original purchase, and provided the serial number has been made known to us promptly for our records.

This warranty does not apply to any of our products which have been repaired or altered by unauthorized persons or service stations in any way so as, in our judgment, to injure their stability or reliability or which have been subject to misuse, negligence, or accident, or which have had the serial number altered, effaced, or removed. Neither does this warranty apply to any of our products which have been connected, installed, or adjusted otherwise than in accordance with the instructions furnished by us. Accessories including all vacuum tubes not of our manufacture used with this product are not covered by this warranty.

This warranty is in lieu of all other warranties expressed or implied and no representatives or person is authorized to assume for us any other liability in connection with the sale of our products.

Parts will be made available for a minimum period of five (5) years after the manufacture of this equipment has been discontinued. Parts include all materials, charts, instructions, diagrams, accessories, etc., which have been furnished in the standard model.

RETURNING EQUIPMENT FOR REPAIR

Before returning any equipment for service, under warranty or otherwise, the factory must first be contacted giving the nature of the trouble. Instructions will then be given for either correcting the trouble or returning the equipment. Address all service inquiries to The Hickok Electrical Instrument Company, 10514 Dupont Avenue, Cleveland 8, Ohio.

SECTION 1 - DESCRIPTION

1.1 PURPOSE

The Hickok Electronic Volt-Ohmmeter, Model 215, shown in Figure 1.1, is a compact universal test instrument which may be used in making measurements in the study of radio and electrical circuits. It is a versatile instrument for use in connection with wide ranges of AC and DC voltages and resistances. Built under Hickok's high standards of workmanship, it is an accurate and durable test instrument.

1.2 DESCRIPTION

a. Physical

The instrument is enclosed in a shatterproof case with a leather carrying strap at the top, and may be used in either a horizontal or vertical position. The chassis is mounted on the front panel and is accessible by removing the 7 screws around the outer edge of the case and then removing the panel. The meter is accurately calibrated with the scales clearly marked. A mechanical adjustment of the zero setting is provided on the front of the meter.

A special AC-DC cable and probe assembly is supplied for voltage measurements, together with a red ohmmeter test lead and a black ground lead.

b. Functional

The Model 215 is designed to perform the following electrical functions:

(1) To measure a wide range of AC and DC voltages and resistances.

(2) To have a very light loading effect on the circuit under test, thereby insuring greater accuracy.

(3) To have a meter circuit design which will eliminate the possibility of damage to the meter due to overload.

c. Electrical

A 105-125 volt, 50-1200 cycle AC external power source is required for the operation of the power supply system which has been incorporated in the unit to supply all DC plate voltages and AC heater voltages. The power supply circuit is of the conventional type consisting of a transformer, rectifier, and filter. A self-contained dry cell supplies the necessary DC voltage for making ohms measurements.

SECTION 2 - THEORY

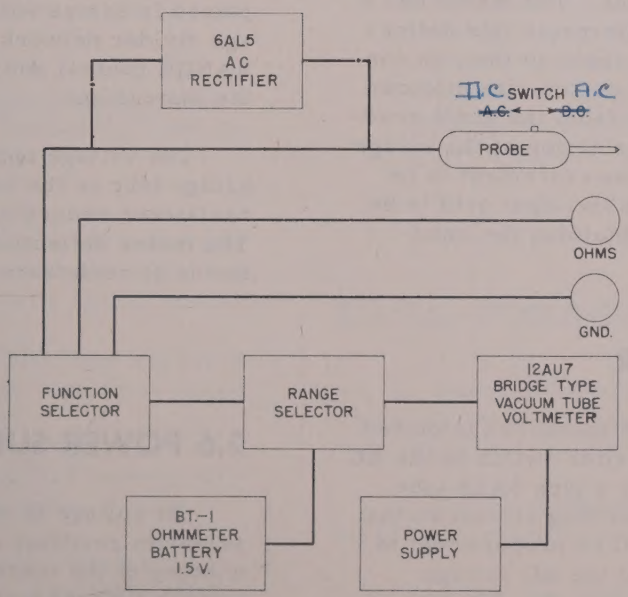


FIGURE 2.1 BASIC CIRCUITS, BLOCK FORM

2.1 GENERAL

A thorough understanding of the theory behind the operation of any instrument will enable the user to obtain greater utility and satisfaction from the instrument. For this reason, the following brief explanation of the circuit of this instrument is given.

2.2 BRIDGE CIRCUIT

a. The bridge circuit is common to all measuring circuits. Specific application of the bridge is given in the explanation of the type of measurement to be performed, i.e., resistance sistance or voltage.

b. The basic circuit of the bridge is similar to the common Wheatstone bridge in operation. Voltage is applied across the bridge; B+ at R15 and B-, through feeder resistor R29, at the junction of R13 and R14. R15 acts as a zero adjustment and is adjusted so that with no voltage input to either grid of the tube, the meter reads zero, indicating balance between the two triodes of the twin triode used as the bridge tube. When making all measurements the grid of one triode remains at ground potential and the grid of the other triode changes to a potential determined basically by the unknown being measured. Changing the potential of only one of the grids will unbalance the bridge and cause a deflection of the meter in direct proportion to the change in grid potential, as the plate current changes with grid potential. The meter has a calibrated scale which interprets this deflection in terms of volts or ohms so that, in conjunction with the RANGE switch, the unknown can be evaluated directly from the scale reading. This is basically the action of the bridge and meter. The type of measurement to be made will determine both the input grid to be used and the method of obtaining the input voltage.

2.3 A.C. VOLTMETER

The AC voltage to be measured is picked up by the probe with the slide switch in the AC position, and rectified by a type 6AL5 tube connected in a voltage doubling circuit so that the measured voltage will be proportional to the peak-to-peak value of the AC voltage applied. After rectification, this DC voltage is fed through the FUNCTION SELECTOR and RANGE SELECTOR switches and applied to the bridge vacuum tube voltmeter circuit. The indicator is calibrated in terms of the RMS value of the AC voltage being measured.

In the case of irregular or assymetrical AC voltages, the peak-to-peak value of the voltage being measured can be calculated by multiplying the indicated voltage by 2.8.

2.4 D.C. VOLTMETER

With the probe slide switch in the DC position, the voltage being measured is fed directly through the FUNCTION SELECTOR and RANGE SELECTOR switches to the bridge vacuum tube voltmeter. The SELECTOR switch permits DC voltages, either positive or negative with respect to ground, to be measured. By advancing the ZERO ADJUST control the meter, with zero volts in, can be brought to center scale providing for a zero center DC voltage measurement.

2.5 OHMMETER

When an unknown resistance is connected across the OHMS and GND terminals it is placed in series with a portion of the input voltage divider network as determined by the RANGE control and the dry cell incorporated in the instrument.

The voltage applied to the input grid of the bridge tube is the voltage across the unknown resistance caused by the battery current flow. The meter deflection can be calibrated in the terms of resistance.

2.6 POWER SUPPLY

B+ voltage is obtained by means of a selenium rectifier connected to the secondary winding of the transformer and the resultant voltage filtered by means of R30 and C5.

SECTION 3 - OPERATION

CAUTION

THE HIGH VOLTAGES WHICH CAN BE MEASURED WITH THIS INSTRUMENT MAY BE DANGEROUS TO LIFE. EXTREME CARE SHOULD BE TAKEN TO AVOID BODILY CONTACT WITH EXPOSED HIGH VOLTAGES.

3.1 GENERAL

a. To avoid error in resistance measurements, be sure that the unknown to be measured is isolated from other circuits. It is sufficient to free only one terminal of the resistor.

b. Be sure that the instrument is being operated from the correct external power source. It is necessary to allow a two or three minute warmup period so that stable operation is assured. If the instrument is to be used intermittently over a period of time, it is advisable to keep it turned on to avoid delay.

3.2 A.C. VOLTAGE MEASUREMENTS

a. Operate the SELECTOR switch to AC VOLTS.

b. Operate the slide switch on the probe to AC which is the position ~~back away from~~ Towards the prod.

c. Connect the black unshielded test lead to the GND jack and also to one side of the AC voltage to be measured. In the case of TV and radio sets, this would nominally be the chassis.

d. Turn the RANGE SELECTOR switch to a range which is thought to be within the range of the voltage to be measured.

e. Adjust the ZERO ADJUST control until the meter indicates zero voltage.

f. Connect the probe to the other side of the source of AC voltage and read this voltage on a corresponding range.

g. If the voltage is being read on the 1.5 or 3 volt range, be sure it is read on the RMS--A.C. VOLTS ONLY scale. If the range being used is 12 volts or higher, read on the corresponding DC--RMS VOLTS scale. If it is desired to know the peak-to-peak value of the voltage being measured, it is only necessary to use corresponding PEAK-TO-PEAK scales. The corresponding scales are listed below:

RMS	PEAK-TO-PEAK
1.5	4.0
3.0	8.0
12.0	32.0
30.0 (3 V. scale)	80.0
120.0 (12 V. ")	320.0
300.0 (3 V. ")	800.0
1200.0 (12 V. ")	3200.0

h. A.C. Frequency Characteristics--The input capacity of the AC measuring circuits is approximately 150 to 200 mmf using the standard cable. Voltage measurements to frequencies of well over 1 mc can be expected to be accurate. If the source impedance of the voltage being measured is relatively low, measurements to many times this can also be made.

NOTE

IF THE SLIDE SWITCH ON THE PROBE WERE ACCIDENTALLY TURNED TO THE DC POSITION, THE INSTRUMENT WOULD STILL READ AC VOLTS BUT THE READINGS WOULD BE APPROXIMATELY 10% LOW.

3.3 D.C. VOLTAGE MEASUREMENTS

a. Operate the SELECTOR switch to either -DC or +DC, depending upon the polarity to be measured with respect to ground.

b. Set the RANGE switch to the range which will cover the voltages to be measured.

c. Adjust the ZERO ADJUST control so that the meter indicates at zero volts.

d. Connect the ground lead to the chassis of the receiver being tested or to one side of the DC voltage to be measured.

e. Operate the slide switch on the probe forward to the DC position.

f. Connect the probe to the other side of the DC voltage being measured.

g. Considering the range being used, read the voltage directly from the DC--RMS VOLTS scales.

NOTE

To use the zero center voltage scales merely operate the ZERO ADJUST control, with no voltage being applied, until the pointer comes up to zero on the lower DC scales. These scales are calibrated from zero center to 1.5 and 6 volts either side. If the range selector is on the 3, 30 or 300 volt range, the lower 0 - 1.5 scale should be used and the readings multiplied by 1, 10 and 100 respectively. If the 12, 120 or 1200 volt ranges are being used, the upper arc should be read. On the 12 volt range the readings would be direct. On the 120, multiply by 10, and on the 1200 multiply by 100.

If the 1.5 volt range is being used the readings should be taken from the lower 0 - 1.5 volt arc and divided by 2. In this case, of course, from zero either right or left would be .75 volt full scale.

3.4 RESISTANCE MEASUREMENTS

a. Operate the SELECTOR switch to OHMS.

b. Operate the RANGE SELECTOR to a suitable range, giving consideration to the resistance being measured.

c. Connect the unshielded black test lead to the GND pin jack on the panel.

d. Connect the unshielded red lead to the OHMS pin jack.

e. Short the two leads together and adjust the ZERO ADJUST for zero on the ohms scale.

f. Unshort the two test leads or remove the red lead from the OHMS Jack and adjust the OHMS ADJUST control for reading of full scale, or INF., on the OHMS range.

g. Connect the test leads across the unknown resistance making sure that it is isolated from any other circuit components which might introduce error.

h. Read the numerical value from the OHMS scale directly and apply the proper multiplication factor.

SECTION 4 - MAINTENANCE

4.1 GENERAL

As the Model 215 has been built under the high standards of workmanship of a Hickok instrument, no maintenance other than routine replacement of tubes or battery should be necessary. It is suggested that, should the instrument need maintenance other than routine replacements, the factory be contacted with regard to the nature of the trouble, and if necessary, the instrument be shipped to the factory or an authorized Hickok service station for inspection and service. Figure 4.1 showing tube locations, and the schematic wiring diagram, Figure 5.1, are given to aid in maintenance work.

4.2 VACUUM TUBES

All vacuum tubes are operated at, or below, their normal rating to insure long life and uniform service. To check the tubes, remove the chassis from the case by removing the 7 screws around the edge of the case and lifting the panel from the case.

4.3 DRY CELLS

One dry cell is used as a source of DC in making ohmmeter measurements. If it is impossible to bring the meter to full scale deflection on any scale it is probable the dry cell is low. To replace this, remove the chassis from the case as explained in paragraph 4.2, and re-

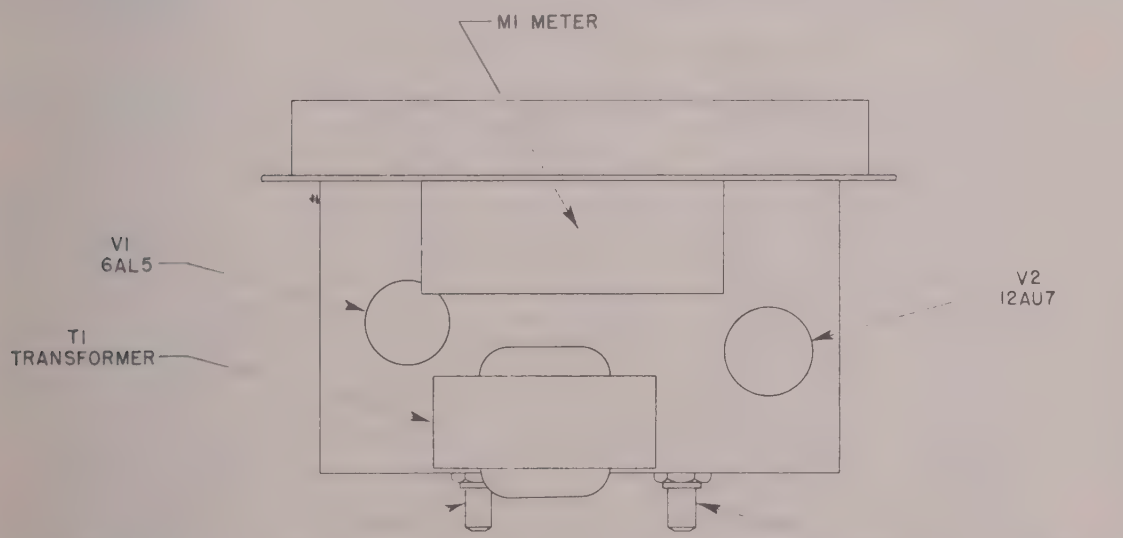
move the dry cell. It will be necessary to remove the clamp holding the cell in place before removing the cell from its clip holder.

4.4 RESISTANCE MEASUREMENTS

When making resistance measurements with the Model 215, a condition is often encountered which is very confusing unless explained. This is caused by stray AC pickup of the test leads reacting to cause the meter pointer's inability to be properly adjusted to full scale. This stray field is almost always present wherever there is 110 volt wiring, and especially prevalent where fluorescent lamps are used.

When using the most sensitive ranges of this instrument, the following procedure should be used. First, turn the RANGE SELECTOR to the lowest (XI) range. Short the test leads together and adjust the zero control to zero ohms. Open up the test leads and adjust the OHMS ADJUST control to bring the meter up to infinity ohms. Disconnect the red test lead from the OHMS Jack and rotate the RANGE control to the desired range. The pointer will probably not drop back to very much below the INF. position. If it does come down below this point, readjust the OHMS ADJUST control to bring the indicator up to the INF. position.

If reinserting the red lead in the OHMS jack affects the reading under these conditions, then the resistance being measured should preferably be connected directly between the OHMS jack and the black, or ground, test lead.



TOP VIEW OF CHASSIS
MODEL 215

FIGURE 4.1 TUBE LOCATIONS

PARTS LIST FOR MODEL 215

NOTE: There is a minimum billing charge of $1.50 for any one parts order. Prices will be furnished upon request.

REF SYMBOL	HICKOK CODE NO.	NAME AND DESCRIPTION	FUNCTION
BT1	2210-1	BATTERY: unit cell, Size C, 1.5 Volt National Carbon #935	
C1	3105-141	CAPACITOR: .1 mfd, 1000 V, paper	
C2	3105-7	CAPACITOR: .025 mfd, 400 V	
C3	3115-2	CAPACITOR: 6.5-35 mmf. trimmer	
C4	3095-41	CAPACITOR: 2700 mmf, 500 V, 10%, mica	
C5	3085-49	CAPACITOR: 10 mfd, 200 V, electrolytic	
C6		CAPACITOR: Same as C2	
R8	16925-142	POTENTIOMETER: 15,000 ohms, linear, carbon	ZERO ADJUST
R17	16925-143		
R17	16925-143	POTENTIOMETER: 10,000 ohms, linear, carbon, screw driver slot	-DC CALIBRATION
R18		POTENTIOMETER: Same as R8	OHMS ADJUST
R19		POTENTIOMETER: Same as R17	+DC CALIBRATION
R35	16925-144	POTENTIOMETER: 2000 ohms, linear, screw driver slot	CONTACT BUCKING POTEN.
CR1	18150-18	RECTIFIER: selenium, Radio Receptor 8Y1	
R1	18414-562	RESISTOR: 560,000 ohms, 1/2 W, 10%	
R2	18525-440	RESISTOR: 5 megohms, 1/2 W, 1%	
R3	18525-436	RESISTOR: 9 megohms, 1/2 W, 1%	
R4	18525-385	RESISTOR: 3.75 megohms, 1/2 W, 1%	
R5	18525-467	RESISTOR: 900,000 ohms, 1/2 W, 1%	
R6	18525-463	RESISTOR: 750,000 ohms, 1/2 W, 1%	
R7	18525-455	RESISTOR: 90,000 ohms, 1/2 W, 1%	
R9	18525-459	RESISTOR: 1 megohm, 1/2 W, 1%	
R10	18525-465	RESISTOR: 375,000 ohms, 1/2 W, 1%	
R11	18525-456	RESISTOR: 9000 ohms, 1/2 W, 1%	
R12	18415-331	RESISTOR: 3.3 megohms, 1/2 W, 5%	
R13	18413-391	RESISTOR: 39,000 ohms, 1/2 W, 5%	
R14	18413-361	RESISTOR: 36,000 ohms, 1/2 W, 5%	
R15	18525-464	RESISTOR: 75,000 ohms, 1/2 W, 1%	
R16	18525-457	RESISTOR: 900 ohms, 1/2 W, 1%	
R20	18525-461	RESISTOR: 770,000 ohms, 1/2 W, 1%	
R21	18525-460	RESISTOR: 37,500 ohms, 1/2 W, 1%	
R22	18525-458	RESISTOR: 90 ohms, 1/2 W, 1%	
R23	18415-472	RESISTOR: 4.7 megohms, 1/2 W, 10%	
R24	18525-462	RESISTOR: 210,000 ohms, 1/2 W, 1%	
R25	18525-466	RESISTOR: 12,500 ohms, 1/2 W, 1%	
R26	18525-446	RESISTOR: 9.75 ohms, 1/2 W, 1%	
R27	18412-181	RESISTOR: 1800 ohms, 1/2 W, 5%	
R28		RESISTOR: Same as R27	
R29	18413-472	RESISTOR: 47,000 ohms, 1/2 W, 10%	
R30	18412-222	RESISTOR: 2200 ohms, 1/2 W, 10%	
R31	18413-512	RESISTOR: 51,000 ohms, 1/2 W, 10%	
R32	18575-98	RESISTOR: 90 megohms, 2 W, 1%	

PARTS LIST FOR MODEL 215

NOTE: There is a minimum billing charge of $1.50 for any one parts order. Prices will be furnished upon request.

REF SYMBOL	HICKOK CODE NO.	NAME AND DESCRIPTION	FUNCTION
R33		RESISTOR: approx. 25 megohms, AC calibration	
R34	18412-472	RESISTOR: 4700 ohms, 1/2 W, 10%	
R36	18413-562	RESISTOR: 56,000 ohms, 1/2 W, 10%	
S1	19912-226	SWITCH: rotary, 4 pole, 4 section, 7 position	RANGE SELECTOR
S2	19912-225	SWITCH: rotary, 5 pole, 2 section, 5 position	FUNCTION SELECTOR
T1	20800-107	TRANSFORMER: power	
V1	20875-51	TUBE: 6AL5	
V2	20875-69	TUBE: 12AU7	
	12450-98	LEAD ASS'Y: red	
	12450-99	LEAD ASS'Y: black	

NOTE: When ordering parts or materials for this instrument, the serial number must be given in order to identify properly the material required.

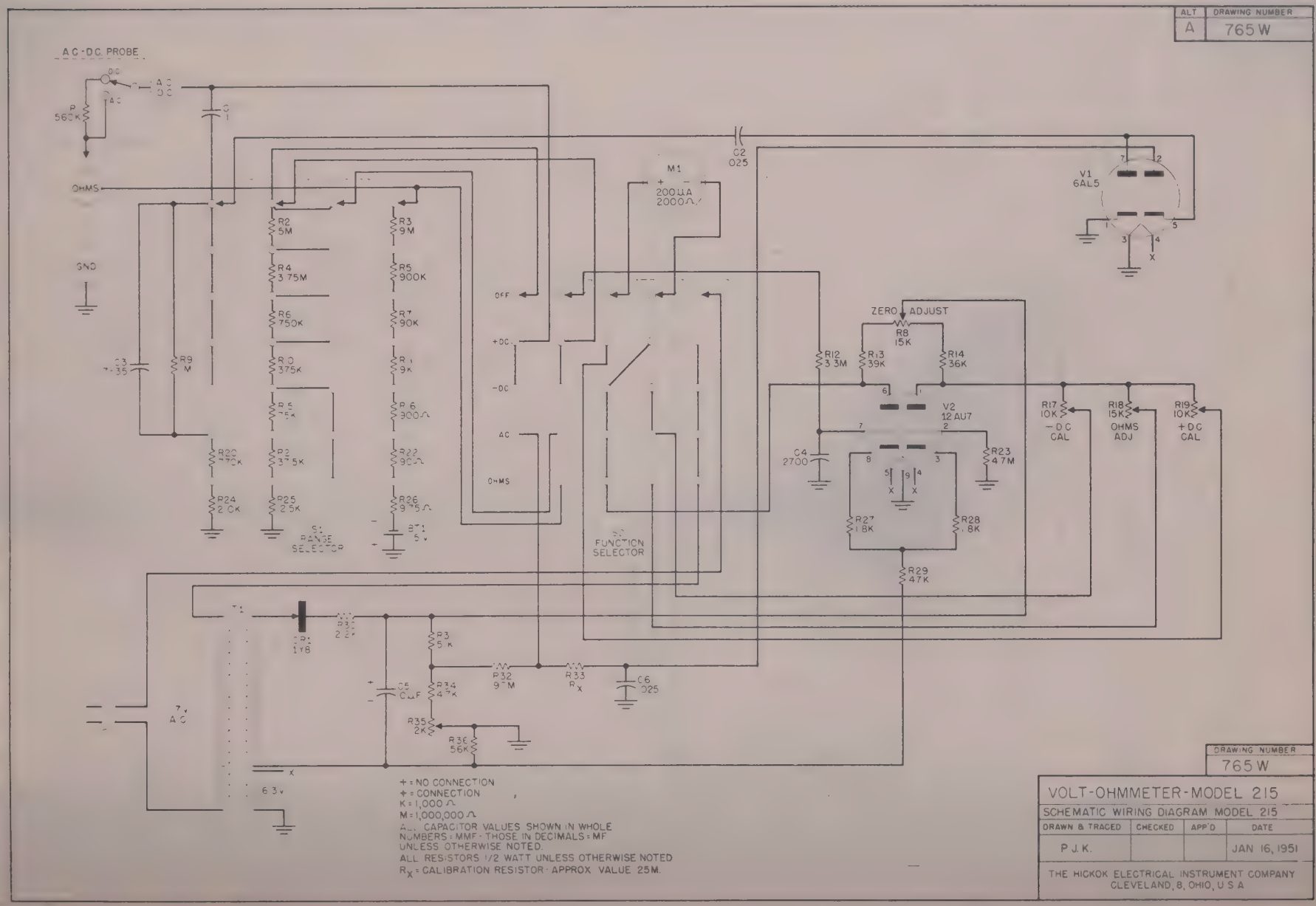
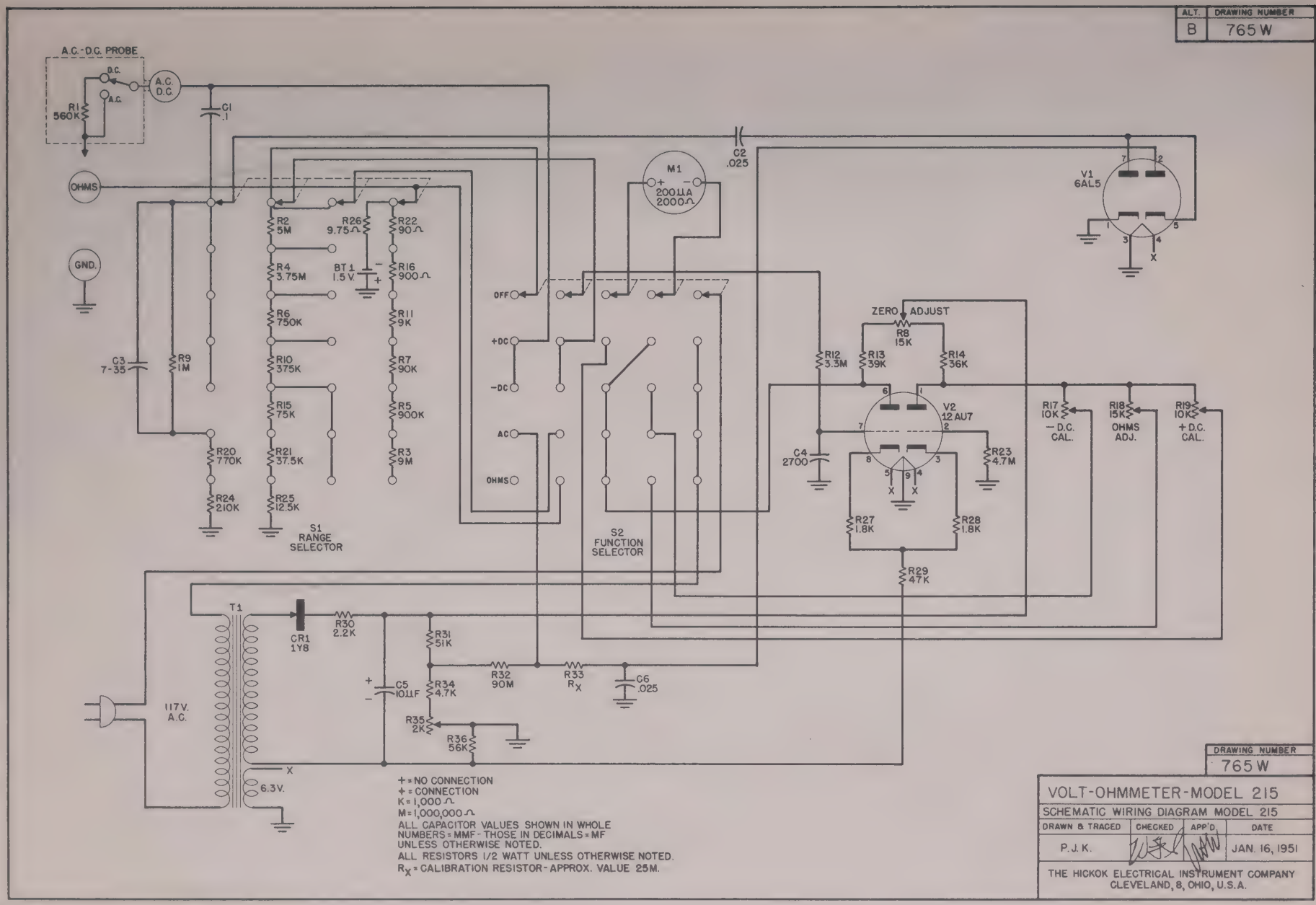


FIGURE 5.1 SCHEMATIC, MODEL 215



+ = NO CONNECTION
+ = CONNECTION
K = 1,000 Ω
M = 1,000,000 Ω
ALL CAPACITOR VALUES SHOWN IN WHOLE NUMBERS = MMF - THOSE IN DECIMALS = MF UNLESS OTHERWISE NOTED.
ALL RESISTORS 1/2 WATT UNLESS OTHERWISE NOTED.
R_X = CALIBRATION RESISTOR - APPROX. VALUE 25M.

ALT.	DRAWING NUMBER
B	765 W

DRAWING NUMBER
765 W

VOLT-OHMMETER-MODEL 215

SCHEMATIC WIRING DIAGRAM MODEL 215

DRAWN & TRACED	CHECKED	APP'D	DATE
P. J. K.			JAN. 16, 1951

THE HICKOK ELECTRICAL INSTRUMENT COMPANY
CLEVELAND, 8, OHIO, U.S.A.

HICKOK